DOCUMENT RESUME

ED 243 706 SE 044 477

AUTHOR Fu, Lewis; Edwards, Henry P.
TITLE Mathematics Achievement of English Program and French Immersion Pupils in Grades 3, 6, and 9: A Two-Year Evaluation with Reference to a New System-Based Mathematics Program.
PUB DATE Apr 84
NOTE 32p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 23-27, 1984).
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Bilingual Education; Educational Research; Elementary Secondary Education; Evaluation; *Immersion Programs; *Language of Instruction; *Mathematics Achievement; Mathematics Education; *Mathematics Instruction; Program Descriptions; *Second Languages
IDENTIFIERS *Mathematics Education Research

ABSTRACT

The purpose of the study was to assess the relative mathematics achievement of English-speaking pupils enrolled in grades 3, 6, and 9 in regular English or French immersion programs during the 1981-82 and 1982-83 school years. The data were obtained as part of a 2-year evaluation of a system-based mathematics program developed by an Ontario school board. For grade 3, eight English program and four French immersion classes were selected for each year. For grade 6, the 1981-82 sample consisted of 12 English program classes and the 1982-83 sample consisted of six English program and four French immersion classes. For grade 9, the 1981-82 sample consisted of 12 English program classes, and the 1982-83 sample consisted of 10 English program and two French immersion classes. Most differences between English program and French immersion pupils were small and nonsignificant in grade 3. Results for grades 6 and 9 suggested that the French immersion pupils had comparable or superior mathematics scores than their English program peers. (MNS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED243706

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Mathematics Achievement of English Program and French Immersion Pupils in Grades 3, 6, and 9: A Two-Year Evaluation With Reference to a New System-Based Mathematics Program

Lewis Fu and Henry P. Edwards

University of Ottawa

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY
Lewis Fu
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Paper Presented at the 1984 Annual Meeting of the
American Educational Research Association
New Orleans, Louisiana
April 23-27, 1984

SE044477

The purpose of the present study was to assess the relative mathematics achievement of English-speaking pupils who were enrolled in regular English or French immersion programs during the 1981-82 and 1982-83 school years, in grades 3, 6, and 9. The data presented in this paper were obtained as part of a two-year evaluation of a system-based mathematics program recently developed by a large school board in Ontario, Canada.

The Programs Being Evaluated

The nature of the mathematics program being evaluated has been described elsewhere (Fu & Edwards, 1984). Briefly, the school board decided to develop a detailed mathematics curriculum written as a series of curriculum documents for all grades. The curriculum documents, which had been prepared by specially assigned teachers and consultants, were distributed to all teachers for study and field testing. In grades 3 and 6, these curriculum documents contain four mathematics strands: Arithmetic, geometry, graphing, and measurement. In both grades, each strand is divided into a series of lessons. Each lesson in turn consists of four parts: Objectives, teaching activities/strategies, sample evaluations, and references. The grade 9 mathematics curriculum follows the guidelines published by the Ontario Ministry of Education (The Ontario Ministry of Education, 1980), and contains three mathematics strands: Numerical methods,

---

This paper presents some aspects of an ongoing evaluation of the Carleton Board of Education's mathematics program, contractually funded by the board. The authors gratefully acknowledge the excellent cooperation and support of school board personnel, and note explicitly those of Dr. David Ireland, Mr. Bob Lafleur, Mr. Dave Thorsell, the members of the mathematics team, and all participating teachers and students.

geometry, and algebra. A detailed curriculum document for this grade is presently being prepared by the school board.

Because the school board is located in a bilingual area of Canada, its English schools offer both regular English and French immersion program options for their pupils. French immersion is offered at both elementary and secondary grades. In the early grades (including grade 3), all instruction is provided in French by French-speaking teachers, with the exception of one hour per day devoted to English language arts in grade 3. Grade 3 mathematics, therefore, is taught in French. In grades 4 to 6, the amount of instruction in English is increased, so that grade 6 pupils receive half of their daily instruction in French and the other half, including mathematics, in English. In the secondary schools, a full French immersion program is offered in grade 9 and certain upper grade subjects are taught in French. The grade 9 mathematics curriculum is therefore taught in French by French-speaking teachers.

Mathematics in French Immersion Programs: Previous Studies

Immersion programs, in which the second language (usually French in Canada) is used as the sole or major medium of instruction, have been widely evaluated (see, for example, Bruck, Lambert, & Tucker, 1974, 1976; Edwards, Fu, McCarrey, & Doutriaux, 1981; Genesee, 1978; Genesee & Chaplin, 1976; Genesee, Polich, & Stanley, 1977; Lambert & Tucker, 1972; Swain, 1978). Although the emphasis of these studies has been on the language skills of the pupils, a number of them have also contrasted the subject matter achievement of the French immersion students to that of their cohorts in regular first language programs.

More specifically, Stern, Swain, McLean, Friedman, Harley, & Lapkin (1976) analyzed a large body of data from previous studies of French immersion

in Ontario, and concluded that, when subject-matter (such as mathematics, social studies, etc.) was taught through the medium of the French language, the achievement levels of French immersion and English program pupils were comparable. In a longitudinal study conducted from 1970 to 1976, Genesee (1978) used standardized tests administered in English and in French to study the language skills and subject-matter achievement, including mathematics, of grades 1 to 6 pupils enrolled in French immersion, English school and French school programs respectively. In this study, mathematics was taught in French to the immersion pupils. When the author contrasted the mathematics achievement of the French immersion and English control groups, using two standardized mathematics tests (one in English and the other in French), he concluded that the mathematics achievement of the two groups was comparable. A majority of studies in this area, in fact, support the notion that French immersion programs yield substantial second language acquisition without detriment to first language skills or to levels of achievement in non-language aspects of the curriculum. This pattern of results, whereby the achievement of French immersion pupils is comparable or even superior to that of their unilingually schooled peers, has been found to continue into the secondary years (see the surveys by Genesee & Chaplin, 1976 and by Genesee, Polich, & Stanley, 1977).

Two studies have yielded somewhat discrepant results. Barik, Swain, and Nwanunobi (1977) found that grades 3 and 4 French immersion pupils lagged behind regular English program pupils in mathematics and/or English proficiency measures. Edwards and Fu (1982) studied the mathematics achievement of grade 3 pupils in French immersion and regular English programs, using a locally developed objectives-based mathematics achievement test. They found that, although the pre-test scores of the immersion pupils surpassed those of the

regular English program pupils, their rate of progress in grade 3 mathematics was lower than that of the regular English program pupils as evidenced by gain scores. This notwithstanding, when the post-test scores of these immersion and English program pupils were compared, using I.Q. and pre-test mathematics subscores as multiple covariates, the resulting contrasts still favoured the French immersion group (geometry subscore) or were not statistically significant (Fu & Edwards, 1984).

It may be that, at least under certain circumstances, grade 3 French immersion students lag somewhat below their English program peers on tests of mathematics (Barik, Swain, & Nwanunobi, 1977; Edwards & Fu, 1982). Published evidence suggests, however, that no such lag exists by grade 6 or in secondary school (see Genesee, 1978; Genesee & Chaplin, 1976; Genesee, Polich, & Stanley, 1977).

The present study attempts to provide additional evidence as to the replicability of a mathematics achievement lag in grade 3, when the second language skills of the immersion pupils are quite limited, and to verify its possible disappearance by grades 6 and 9.

Program Stability and Mathematics Achievement

In the present study, the mathematics curriculum being employed in grades 3 and 6 is of recent origin. It had been first field tested in the 1981-82 school year, and implemented on a more stable basis in 1982-83. One of the aims of the present study, therefore, was to examine the mathematics achievement of the pupils during these two years. One would expect that the greater acquaintance of the teachers with the curriculum during the second year (1982-83) would better enable them to transmit it to their pupils, and that this in turn would be reflected in higher mathematics scores on the part of the pupils. In grade 9, because a new mathematics curriculum had not

been introduced prior to or during the two years of this study, comparable levels of mathematics achievement were expected in 1981-82 and 1982-83.

The Research Questions

On the basis of the above considerations, the present study addresses the following questions:

1. Is the mathematics achievement of pupils who followed a new system-wide curriculum in grades 3 and 6 during its second year of implementation superior to that of their peers who followed the same curriculum during its first year of field testing by the teachers?

2. Is the mathematics achievement of pupils who followed a stable grade 9 mathematics curriculum during two successive school years comparable?

3. When the mathematics achievement scores of grade 3 French immersion and regular English program pupils are compared, using a mathematics test that was locally constructed in view of a locally developed system-wide curriculum, do the scores of the French immersion pupils lag behind those of their peers in the regular English program?

4. When the mathematics achievement scores of grade 6 French immersion and regular English program pupils are compared, using a mathematics test that was locally constructed in view of a locally developed system-wide curriculum, are the scores of the French immersion and regular English program pupils comparable?

5. When the mathematics achievement scores of grade 9 French immersion and regular English program pupils are compared, using a mathematics test that was locally constructed in view of the Ontario Ministry of Education guidelines for grade 9 mathematics, are the scores of the French immersion and regular English program pupils comparable?

Method

Samples

The population under study consisted of all pupils in grades 3, 6, and 9 (Advanced Level) who were enrolled in the English or French immersion programs offered by the English schools of a large Ontario, Canada, school board. The sampling units were classes rather than individual pupils, in order to focus on the mathematics program as taught in regular classes. Split-grade classes were excluded from the population before sampling.

Table 1 shows the pupils who participated in the 1981-82 and 1982-83 years of the study, divided according to grade and program of instruction.

Insert Table 1 About Here

Grade 3. Two random samples were drawn from the 1981-82 and 1982-83 populations. In 1981-82, eight (out of 38) English program classes and four (out of 14) French immersion classes were randomly selected. The 1982-83 sample consisted of eight (out of 41) English program classes and four (out of 18) French immersion classes. The entire French immersion curriculum since grade 1 had been taught in French by French-speaking teachers, excepting a daily period of English language arts.

Grade 6. Random samples were drawn from the 1981-82 and 1982-83 populations. The total 1981-82 sample consisted of twelve (out of 81) English program classes. In 1982-83, six (out of 63) English program classes and four (out of 12) French immersion classes were randomly selected. By this grade, the French immersion pupils were taking half of their curriculum including mathematics in English and the other half in French, with English and French-speaking teachers respectively.

Grade 9, Advanced Level. Most grade 9 students, including all French immersion students, are enrolled in this level. Random samples were drawn from the 1981-82 and 1982-83 populations. The total 1981-82 sample consisted of twelve (out of 58) English program classes. In 1982-83, ten (out of 65) English program classes and two French immersion classes (the total population) were randomly selected. These French immersion pupils, who in their majority had taken a French immersion program in elementary school, were being taught mathematics in French by French-speaking teachers.

Instruments

Objectives-based mathematics achievement tests. These tests were developed and validated by the authors (Fu & Edwards, 1981) in cooperation with assigned school board personnel. They were revised prior to the 1982-83 testing in view of certain 1981-82 test item statistics, and in view of recent modifications by the school board to its new mathematics curriculum documents.

The grade 3 and grade 6 tests were intended to reflect the specific objectives and content of the school board's new mathematics curriculum documents for these grades. The grade 9, Advanced Level, test followed the appropriate guidelines of the Ontario Ministry of Education (The Ontario Ministry of Education, 1980), pending the development of a corresponding curriculum document by the school board.

The final version of the grade 3 test has two equivalent forms, A and B, and each is available in English or French. Each form consists of 60 multiple-choice items and yields four subscores in arithmetic (26 items), geometry (11 items), graphing (2 items), and measurement (21 items), as well as a total score.

In grade 6, the test has two equivalent forms, A and B, in English only. Each form consists of 65 multiple-choice items and yields four subscores in

arithmetic (33 items), geometry (9 items), graphing (4 items), and measurement (19 items), as well as a total score.

In grade 9, there is one test form, in English and French versions. It consists of 80 multiple-choice items and yields three subscores in numerical methods (39 items), geometry (17 items), and algebra (24 items), as well as a total score.

Each of the above tests covers the major areas of the mathematics curriculum. The number of test items for each area is in direct proportion to the number of objectives for that area in the school board's new mathematics curriculum document. The length of each test is such that it can be administered in two class periods.

Cattell's Culture Fair Intelligence Test. Form A, Scale 2 of the test was used as a measure of general aptitude, to control statistically for possible differences in the general abilities of the groups to be contrasted. This is a nonverbal, group-administered, paper and pencil, multiple-choice test. This test is well suited for the purpose, having adequate evidence of validity and reliability for a wide age range, across languages and cultures, and being relatively easy to administer and score.

Procedures

The mathematics teachers whose classes had been selected served as test administrators, and thereby made it possible to test all classes within a two-week span.

Prior to each testing session, the authors sent a letter to the Vice-Principals of the participating schools, with specific information about the classes to be tested and the proposed testing dates. Test packages were then delivered to each teacher via the Vice-Principal's office. Each package

contained tests, answer sheets, instructions for test administration, pre-addressed return envelopes, and anything else that might be required by the teacher in order to administer the tests. All classes were tested in May of 1982 or May of 1983.

Grade 3. Form A of the mathematics test (English and French versions respectively) and Cattell's Culture Fair Intelligence Test were administered in May of 1982 and in May of 1983 to the English program and French immersion pupils selected.

In total, 296 pupils were tested in May, 1982 (214 English program and 82 French immersion pupils). In May, 1983, 335 pupils were tested (235 of whom were in the English program and 100 in French immersion).

Grade 6. Form A of the mathematics test (English version only) and Cattell's Culture Fair Intelligence Test were administered in May of 1982 to the English program pupils selected (French immersion pupils had not been sampled in 1981-82). The same two tests (English version only) were administered in May of 1983 to the English program pupils and to the French immersion pupils (because the grade 6 French immersion pupils were taught mathematics in English).

In total, 329 English program pupils were tested in May of 1982, while 185 English program pupils and 114 French immersion pupils were tested in May of 1983.

Grade 9. The mathematics test (English version only) and Cattell's Culture Fair Intelligence Test were administered in May of 1982 to the English program pupils selected (French immersion students had not been sampled in 1981-82). The same two tests, including the French version of the mathematics test for the immersion group, were administered in May of 1983 to the English

program and French immersion pupils selected.

In total, 301 English program pupils were tested in May of 1982 while 239 English program pupils and 54 French immersion pupils were tested in May of 1983.

Data Analyses

Conversion to percents. The raw mathematics scores within each of the mathematics areas at the target grades were converted to percents of correct answers prior to the statistical analyses because the 1981-82 and 1982-83 mathematics tests differed in number of items. To do this, mathematics scores in each area were divided by the total number of items for that area and the resulting quotients were summed, divided by the number of pupils, and multiplied by 100.

Grade 3. A two-way multivariate and univariate analysis of covariance was done to test for group differences on the average percent scores, using general aptitude scores as the covariate. The independent variables were school year (1981-82 vs 1982-83) and program of instruction (that is, English vs French immersion programs). The dependent variables were the four sets of average percents of correct answers corresponding to the arithmetic, geometry, graphing, and measurement subscores.

Grade 6. Two one-way multivariate and univariate analyses of covariance were performed on the grade 6 data, using general aptitude scores as the covariate. The first was a one-way analysis, using the English program classes only, to contrast the 1981-82 vs 1982-83 data. The second was another one-way analysis, using all 1982-83 data, to contrast the English program pupils vs the French immersion pupils. In both analyses, the dependent variables were the average percents of correct answers in arithmetic, geometry, graphing,

and measurement.

Grade 9. Two one-way multivariate and univariate analyses of covariance were carried out, using general aptitude scores as the covariate. The first analysis contrasted the mathematics performance of English program students tested in 1981-82 vs 1982-83. The second analysis, using all 1982-83 data, contrasted the mathematics performance of the English program pupils vs French immersion pupils. In both analyses, the dependent variables were the average percents of correct answers in numerical methods, geometry, and algebra.

Results

This section presents the results of the study on a grade by grade basis. It will be followed by the discussion of results.

Grade 3

Table 2 presents the average mathematics scores of the grade 3 pupils tested in 1981-82 and 1982-83, subdivided according to school year and program of instruction. The mathematics scores are expressed as percents of correct answers, for each area of the mathematics curriculum.

Insert Table 2 about here

The statistics presented in Table 2 form the basis for the inferential analysis presented in Table 3, using Culture Fair I.Q. as the covariate. The mean I.Q.'s of the English program pupils were 111.36 (S.D.=15.38) in 1981-82 and 112.51 (S.D.=13.79) in 1982-83, while those of the French immersion pupils were 119.41 (S.D.=13.05) in 1981-82 and 112.67 (S.D.=12.70) in 1982-83.

Insert Table 3 about here

Table 3 presents the results of the two-way multivariate and univariate analysis of covariance carried out on the grade 3 data. The multivariate contrast by school year (1981-82 vs 1982-83) yielded a statistically significant main effect (multivariate $F_{(4, 623)} = 10.97$, $p < .001$), and significant univariate contrasts on the arithmetic, graphing, and measurement subscores. According to these contrasts, the 1981-82 pupils as a group obtained significantly higher scores than those tested in 1982-83, in the arithmetic, graphing, and measurement subtests.

These results are contrary to the authors' initial expectancy that the teachers' increasing familiarity with the mathematics curriculum document during the second year of the study would be reflected in higher mathematics scores on the part of the pupils.

In Table 3, the multivariate contrast of English vs French immersion program pupils was statistically significant (multivariate $F_{(4, 623)} = 5.04$, $p < .001$), as was the univariate contrast involving geometry. Specifically, the English program pupils as a group (combining the two years) obtained higher geometry scores than did the French immersion pupils. The interaction between school year (1981-82 vs 1982-83) and program of instruction (regular English vs French immersion) was statistically significant at the multivariate level ($F_{(4, 623)} = 2.87$, $p < .05$), and at the univariate level for the arithmetic subscores. This interaction is presented in Figure 1.

Insert Figure 1 about here

As shown in Figure 1, the grade 3 arithmetic achievement of the French immersion pupils was higher in 1981-82 but lower in 1982-83 than that of the regular English program pupils.

Accoring to the contrasts of grade 3 English program and French immersion pupils, therefore, most differences are small and non-significant. Only the contrasts of geometry scores for the two years combined, and of arithmetic scores in 1982-83, provide evidence suggesting a mathematics achievement lag on the part of the grade 3 French immersion pupils.

Grade 6

Table 4 presents the average mathematics scores of the grade 6 pupils tested in 1981-82 and 1982-83, subdivided according to school year and program of instruction. The scores are expressed as percents of correct answers, for each area of the mathematics curriculum.

Insert Table 4 about here

The statistics presented in Table 4 form the basis for the inferential statistics presented in Tables 5 and 6, using Culture Fair I.Q. as the covariate. The mean I.Q.'s of the grade 6 English program pupils were 109.28 (S.D.=13.23) in 1981-82 and 106.61 (S.D.=14.88) in 1982-83. The French immersion pupils, who were sampled and tested only in 1982-83, had a mean I.Q. of 111.30 (S.D.= 11.98).

Table 5 presents the results of a one-way multivariate and univariate analysis of covariance carried out on the grade 6 data.

Insert Table 5 about here

The multivariate contrast by school year (1981-82 vs 1982-83) was statistically significant (multivariate $F_{(4, 508)} = 40.57$, $p < .001$), as were the univariate contrasts on the arithmetic, geometry, and graphing subscores. According to these results, the pupils tested in 1982-83 as a group obtained higher scores than did the 1981-82 pupils in arithmetic and graphing, but lower scores in geometry. The arithmetic and graphing results coincide with the authors' initial expectation, while the geometry result does not.

The contrasts of English program vs immersion groups, 1982-83 only, are presented in Table 6.

Insert Table 6 about here

The multivariate contrast of English program vs French immersion groups yielded a statistically significant value (multivariate $F_{(4, 293)} = 5.61$, $p < .001$), as did the three univariate contrasts on the arithmetic, geometry, and graphing subscores. More specifically, the French immersion pupils obtained higher scores in these three areas of the mathematics curriculum than those of their cohorts in the regular English program.

To summarize, the contrasts of grade 6 English program and French immersion pupils, rather than suggesting an achievement lag on the part of the French immersion group, indicate that these pupils tended to obtain significantly higher mathematics scores than their English program peers.

Grade 9

Table 7 presents the average mathematics scores of the grade 9 students tested in 1981-82 and 1982-83, subdivided according to school year and program of instruction. The mathematics scores are expressed as percents of correct answers, for each area of the mathematics curriculum.

Insert Table 7 about here

The statistics presented in Table 7 form the basis for the inferential analyses presented in Tables 8 and 9, using I.Q. as covariate. The mean I.Q.'s of the English program pupils were 110.36 (S.D.=14.40) in 1981-82 and 109.24 (S.D.=14.36) in 1982-83. The French immersion pupils, who were only sampled and tested in 1982-83, had a mean I.Q. of 116.44 (S.D.=14.14).

Insert Table 8 about here

Table 8 presents the results of a one-way multivariate and univariate analysis of covariance contrasting the mathematics performance of the English program groups tested in 1981-82 and 1982-83. Although the multivariate contrast by school year was statistically significant ($F_{(3, 535)}=38.42$, $p < .001$), none of the univariate F ratios were significant. In fact, no consistent pattern of differences can be identified when contrasting the performance of the grade 9 groups tested in 1981-82 and 1982-83, and each performance difference tends to be quite small.

The contrasts of regular English program vs French immersion groups, in 1982-83 only, are presented in Table 9.

Insert Table 9 about here

The multivariate contrast of English program vs French immersion groups was statistically significant ($F_{(3, 288)}=5.74$, $p < .001$), as was the univariate contrast for the numerical methods subtest. According to these results, the French immersion pupils were comparable to their English program peers on geometry and algebra, but they were superior to the English program group in the area of numerical methods.

These results are consistent with those found in grade 6, to the effect that the mathematics achievement of the French immersion pupils is comparable or superior to that of pupils in a regular English program.

Discussion

The following paragraphs consider the above results in the light of the five research questions of this study.

In response to the first question, the grade 3 results are contrary to initial expectation, in that the mathematics achievement of the 1981-82 pupils was found to be superior to that of the 1982-83 pupils. The grade 6 results are not unequivocal. The superior 1982-83 scores in arithmetic and graphing are in keeping with the idea that increasing teacher familiarity with the mathematics curriculum document is related to higher achievement scores on the part of the pupils, but the lower 1982-83 geometry scores are counter to this notion.

On the basis of the grades 3 and 6 data, therefore, the authors must conclude that pupil achievement during the field testing and early implementation of a new program depends on multiple factors, of which teacher familiarity with the curriculum in question is only one. In any case, the similar mean I.Q.'s obtained by these groups of pupils in 1981-82 and 1982-83 suggest that factors other than general ability of the groups account for the observed results.

With reference to the second question, the grade 9 results did not fluctuate markedly from 1981-82 to 1982-83. Since the grade 9 curriculum followed by these two groups of students had not been substantially modified by the school board in recent years (its revision is presently under way), stable year to year results were expected by the authors at this grade, as confirmed by the results.

In response to the third question posed by this study, the grade 3 results provide only tenuous support for the notion of a subject-matter achievement lag on the part of the French immersion pupils (Barik, Swain, & Nwanunobi, 1977; Edwards & Fu, 1982). Such a lag was observed in this study only with reference to the geometry (during two years combined) and arithmetic (in 1982-83 only) subscores. The remaining contrasts did not reach statistical significance. Given that the mathematics tests used have been shown to be valid and reliable by the authors (Fu & Edwards, 1981), that the study controlled for I.Q. and for program of instruction (English and French versions of the identical mathematics curriculum were at the disposal of the English program and French immersion teachers), and that both groups of pupils were tested with French and English versions of the same mathematics test, these findings are more supportive of the notion that the second language skills of the grade 3 pupils do not

interfere in any substantial way with their mathematics achievement than they are of the existence of a subject-matter lag in mathematics.

The fourth and fifth questions of this study are conceptually similar. The grade 6 and grade 9 findings indicate that the French immersion pupils tend to surpass their English program peers in mathematics achievement (in number concepts at both grades, and also in graphing and geometry at grade 6), or to obtain comparable scores. These results present a picture which is, if anything, more optimistic than that presented by much published literature (see, for example, Genesee, 1978; Genesee & Chaplin, 1976; Genesee, Polich, & Stanley, 1977; Stern, Swain, McLean, Friedman, Harley, & Lapkin, 1976), which has concluded that the non-language subject-matter achievement of French immersion students is usually comparable to that of students in regular first language school programs.

To conclude, this paper has presented results obtained within the context of an evaluation of the mathematics program in an Ottawa, Canada, school board. There were two purposes: To compare the performance of pupils during two successive school years, and to contrast the mathematics performance of English program vs French immersion pupils in grades 3, 6, and 9. The contrasts across years yielded inconsistent results. The contrasts of English vs French immersion pupils strongly suggested that, if there is an early (grade 3) lag in mathematics achievement, it disappears no later than grade 6. In grades 6 and 9, the mathematics performance of the French immersion pupils was comparable or superior to that of their English program peers.

References

Barik, H. C., Swain, M., & Nwanunobi, E. A. English-French bilingual education: The Elgin study through grade five. The Canadian Modern Language Review, 1977, 33, 459-475.

Bruck, M., Lambert, W. R., & Tucker, G. R. Bilingual schooling through the elementary grades: The St. Lambert project at grade seven. Language Learning, 1974, 24, 183-204.

Bruck, M., Lambert, W. E., & Tucker, G. R. Alternative forms of immersion for second language teaching. Working Papers on Bilingualism, 1976, 10, 22-73.

Edwards, H. P., & Fu, L. Evaluation study of the CBE's new mathematics program in grades three, six, and nine: Baseline data phase (Report No. 2). Ottawa, Ontario: The Carleton Board of Education, 1982.

Edwards, H. P., Fu, L., McCarrey, H., & Doutriaux, C. Partial French immersion for English-speaking pupils in elementary school: The Ottawa Roman Catholic Separate School Board study in grades one to four. The Canadian Modern Language Review, 1981, 37, 283-296.

Fu, L., & Edwards, H. P. Evaluation study of the CBE's new mathematics program in grades three, six, and nine: Construction and validation of the objectives-based mathematics tests (Report No. 1). Ottawa, Ontario: The Carleton Board of Education, 1981.

Fu, L., & Edwards, H. P. Mathematics achievement: Effects of language of instruction and teachers' use of new mathematics materials. Canadian Journal of Behavioural Science, 1984, in press.

Genesee, F. A longitudinal evaluation of an early immersion school program. Canadian Journal of Education, 1978, 3, 31-50.

Genesee, F., & Chaplin, S. Evaluation of the 1974-75 grade 11 French immersion class. A report submitted to the Protestant School Board of Greater Montreal, 1976.

Genesee, F., Polich, E., & Stanley, M. H. An experimental French immersion program at the secondary level-1969 to 1974. The Canadian Modern Language Review, 1977, 33, 318-332.

Lambert, W. E., & Tucker, G. R. The bilingual education of children: The St. Lambert experiment. Rowley, MA: Newbury House, 1972.

Stern, H. H., Swain, M., McLean, L. D., Friedman, R. J., Harley, B., & Lapkin, S. Three approaches to teaching French. Toronto: The Ontario Ministry of Education, 1976.

Swain, M. French immersion: Early, late or partial? The Canadian Modern Language Review, 1978, 34, 557-585.

The Ontario Ministry of Education. Mathematics curriculum guide for the intermediate division, 1980.

Table 1

Number of Pupils Tested at Each Grade and Program in the 1981-82 and 1982-83 School Years

		1981-82 School Year			1982-83 School Year		
Grade	Program	Classes in Population	Classes Selected	Pupils Tested	Classes in Population	Classes Selected	Pupils Tested
3	English	38	8	214	41	8	235
	French Imm.	14	4	82	18	4	100
6	English	81	12	329	63	6	185
	French Imm.				12	4	114
9	English	58	12	301	65	10	239
	French Imm.				2	2	54

Table 2

Average Percents of Correct Answers and Standard Deviations of Grade 3 Pupils' Mathematics End-of-Year Scores, by School Year and Program of Instruction

Year/Program	No. of Classes	n	Mathematics Strand: Arithmetic %	Arithmetic S.D.	Geometry %	Geometry S.D.	Graphing %	Graphing S.D.	Measurement %	Measurement S.D.
1981-82 School Year										
English	8	214	52.88	16.43	50.85	20.36	63.55	36.62	57.13	16.08
French Imm.	4	82	60.01	19.22	53.50	20.86	70.12	35.88	61.55	18.58
1982-83 School Year										
English	8	235	53.31	15.63	56.17	20.97	54.68	38.94	51.73	17.11
French Imm.	4	100	48.31	14.50	46.10	19.22	50.00	38.92	48.05	17.62

Table 3

Two-Way Multivariate and Univariate Analysis of Covariance for Grade 3 Pupils' Mathematics End-of-Year Scores (I.Q. as Covariate), by School Year and Program of Instruction

Source of Variation	Multivariate F (4, 623)	Univariate F (1, 626)
School Year (1981-82 vs 1982-83)	10.97***	
Arithmetic		4.69*
Geometry		0.27
Graphing		15.37***
Measurement		34.09***
Program of Instruction (English vs French Immersion)	5.04***	
Arithmetic		1.27
Geometry		22.46***
Graphing		0.78
Measurement		1.97
Interaction	2.87*	
Arithmetic		9.60**
Geometry		1.41
Graphing		0.48
Measurement		2.16

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 4

Average Percents of Correct Answers and Standard Deviations of Grade 6 Pupils' Mathematics End-of-Year Scores, by School Year and Program of Instruction

Year/Program	No. of Classes	n	Mathematics Strand							
			Arithmetic		Geometry		Graphing		Measurement	
			%	S.D.	%	S.D.	%	S.D.	%	S.D.
1981-82 School Year										
English	12	329	46.75	17.32	36.08	17.15	35.10	26.16	35.06	15.17
1982-83 School Year										
English	6	185	48.44	15.21	32.13	15.28	40.81	27.02	32.49	12.93
French Imm.	4	114	58.85	15.12	39.67	18.55	41.50	21.75	36.95	15.68

Table 5

One-Way Multivariate and Univariate Analysis of Covariance for Grade 6 Pupils' Mathematics End-of-Year Scores (I.Q. as Covariate), by School Year

Contrast	Multivariate F (4, 508)	Univariate F (1, 511)
1981-82 vs 1982-83 School Year (Using English Classes Only)	40.57***	
Arithmetic		5.34*
Geometry		4.92*
Graphing		8.90**
Measurement		1.61

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 6

One-Way Multivariate and Univariate Analysis of Covariance for Grade 6 Pupils' Mathematics End-of-Year Scores (I.Q. as Covariate), by Program of Instruction

Contrast	Multivariate F (4, 293)	Univariate F (1, 296)
English vs French Immersion (Using 1982-83 Data Only)	5.61***	
Arithmetic		4.12*
Geometry		7.65**
Graphing		4.84*
Measurement		3.17

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 7

Average Percents of Correct Answers and Standard Deviations of Grade 9 Pupils' Mathematics End-of-Year Scores, by School Year and Program of Instruction

Year/Program	No. of Classes	n	Mathematics Strand: Numerical Methods X	Numerical Methods S.D.	Geometry X	Geometry S.D.	Algebra X	Algebra S.D.
1981-82 School Year								
English	12	301	51.43	16.29	42.10	17.43	49.63	15.66
1982-83 School Year								
English	10	239	52.47	14.46	40.49	17.30	49.46	14.15
French Imm.	2	54	60.69	15.25	37.59	16.00	49.63	14.62

Table 8

One-Way Multivariate and Univariate Analysis of Covariance for Grade 9 Pupils' Mathematics End-of-Year Scores (I.Q. as Covariate), by School Year

Contrast	Multivariate F (3, 535)	Univariate F (1, 537)
1981-82 vs 1982-83 School Year (Using English Classes Only)	38.42***	
Numerical Methods		1.56
Geometry		0.90
Algebra		0.04

*** $p < .001$

Table 9

One-Way Multivariate and Univariate Analysis of Covariance for Grade 9 Pupils' Mathematics End-of-Year Scores (I.Q. as covariate), by Program of Instruction

Contrast	Multivariate F (3, 288)	Univariate F (1, 290)
English vs French Immersion (Using 1982-83 Data Only)	5.74***	
Numerical Methods		6.66**
Geometry		2.58
Algebra		1.57

* $p < .05$; ** $p < .01$; *** $p < .001$

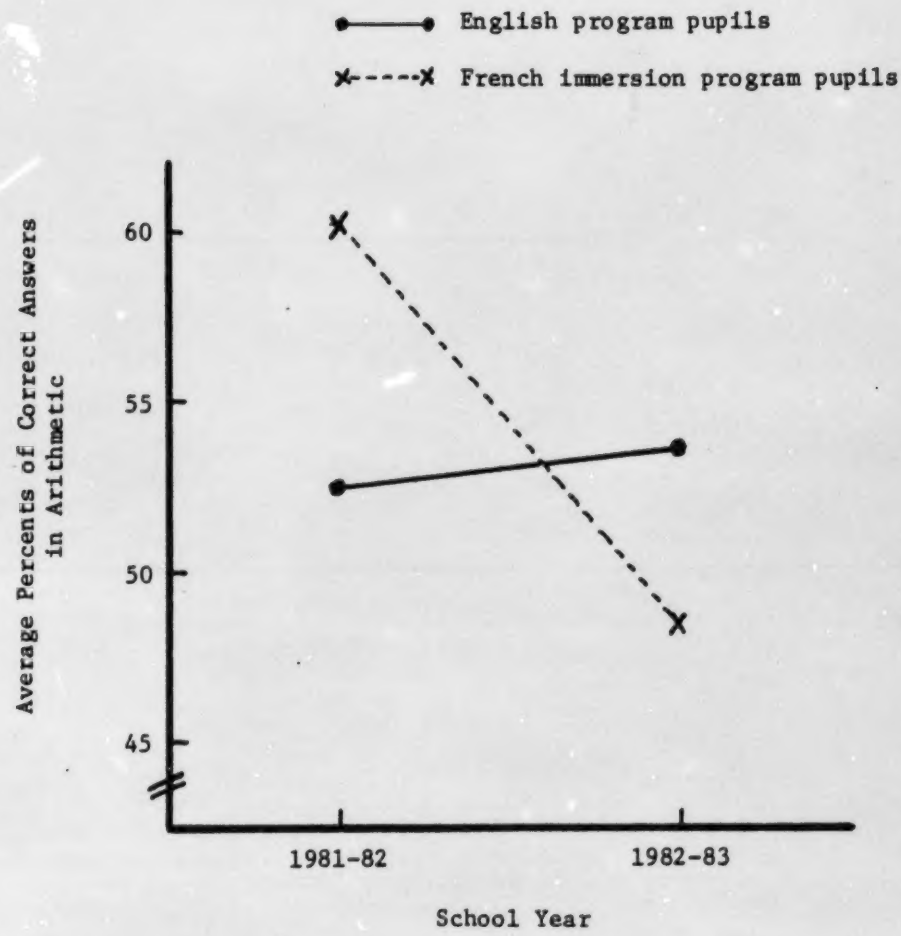

Figure 1. Grade 3 arithmetic scores: Interaction between school year (1981-82 vs 1982-83) and program of instruction (English vs French immersion pupils)